

# PATENT COOPERATION TREATY

## PCT

### INTERNATIONAL PRELIMINARY REPORT ON PATENTABILITY

(Chapter II of the Patent Cooperation Treaty)

REC'D 30 SEP 2005

PCT

#### (PCT Article 36 and Rule 70)

Applicant's or agent's file reference P-IEE-108/WO	<b>FOR FURTHER ACTION</b>		See Form PCT/IPEA/416
International application No. PCT/EP2004/052950	International filing date (day/month/year) 12.11.2004	Priority date (day/month/year) 14.11.2003	
International Patent Classification (IPC) or national classification and IPC B60R21/01, B60N2/00, G01G19/414			
Applicant IEE INTERNATIONAL ELECTRONICS & ENGINEERING S.A.			

<p>1. This report is the International preliminary examination report, established by this International Preliminary Examining Authority under Article 35 and transmitted to the applicant according to Article 36.</p> <p>2. This REPORT consists of a total of 5 sheets, including this cover sheet.</p> <p>3. This report is also accompanied by ANNEXES, comprising:</p> <p>a. <input checked="" type="checkbox"/> (<i>sent to the applicant and to the International Bureau</i>) a total of 11 sheets, as follows:</p> <ul style="list-style-type: none"> <li><input type="checkbox"/> sheets of the description, claims and/or drawings which have been amended and are the basis of this report and/or sheets containing rectifications authorized by this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions).</li> <li><input type="checkbox"/> sheets which supersede earlier sheets, but which this Authority considers contain an amendment that goes beyond the disclosure in the international application as filed, as indicated in item 4 of Box No. I and the Supplemental Box.</li> </ul> <p>b. <input type="checkbox"/> (<i>sent to the International Bureau only</i>) a total of (indicate type and number of electronic carrier(s)) , containing a sequence listing and/or tables related thereto, in computer readable form only, as indicated in the Supplemental Box Relating to Sequence Listing (see Section 802 of the Administrative Instructions).</p>
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<p>4. This report contains indications relating to the following items:</p> <ul style="list-style-type: none"> <li><input checked="" type="checkbox"/> Box No. I Basis of the opinion</li> <li><input type="checkbox"/> Box No. II Priority</li> <li><input type="checkbox"/> Box No. III Non-establishment of opinion with regard to novelty, inventive step and industrial applicability</li> <li><input type="checkbox"/> Box No. IV Lack of unity of invention</li> <li><input checked="" type="checkbox"/> Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement</li> <li><input type="checkbox"/> Box No. VI Certain documents cited</li> <li><input type="checkbox"/> Box No. VII Certain defects in the international application</li> <li><input type="checkbox"/> Box No. VIII Certain observations on the international application</li> </ul>
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Date of submission of the demand 02.06.2005	Date of completion of this report 29.09.2005
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Name and mailing address of the International preliminary examining authority:   European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer  Plenk, R Telephone No. +49 89 2399-7733
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**INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**

International application No.  
PCT/EP2004/052950

**Box No. I Basis of the report**

1. With regard to the **language**, this report is based on the international application in the language in which it was filed, unless otherwise indicated under this item.
  - This report is based on translations from the original language into the following language, which is the language of a translation furnished for the purposes of:
    - international search (under Rules 12.3 and 23.1(b))
    - publication of the international application (under Rule 12.4)
    - international preliminary examination (under Rules 55.2 and/or 55.3)
2. With regard to the **elements\*** of the international application, this report is based on (*replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report*):

**Description, Pages**

1-9 received on 16.09.2005 with letter of 12.09.2005

**Claims, Numbers**

1-6 received on 16.09.2005 with letter of 12.09.2005

**Drawings, Sheets**

1/1 received on 16.09.2005 with letter of 12.09.2005

a sequence listing and/or any related table(s) - see Supplemental Box Relating to Sequence Listing

3.  The amendments have resulted in the cancellation of:

- the description, pages
- the claims, Nos.
- the drawings, sheets/figs
- the sequence listing (*specify*):
- any table(s) related to sequence listing (*specify*):

4.  This report has been established as if (some of) the amendments annexed to this report and listed below had not been made, since they have been considered to go beyond the disclosure as filed, as indicated in the Supplemental Box (Rule 70.2(c)).

- the description, pages
- the claims, Nos.
- the drawings, sheets/figs
- the sequence listing (*specify*):
- any table(s) related to sequence listing (*specify*):

\* If item 4 applies, some or all of these sheets may be marked "superseded."

**INTERNATIONAL PRELIMINARY REPORT  
ON PATENTABILITY**

International application No.  
PCT/EP2004/052950

**Box No. V Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement**

**1. Statement**

Novelty (N)	Yes: Claims	1-6
	No: Claims	
Inventive step (IS)	Yes: Claims	1-6
	No: Claims	
Industrial applicability (IA)	Yes: Claims	1-6
	No: Claims	

**2. Citations and explanations (Rule 70.7):**

**see separate sheet**

**Re Item V**

**V.1 Prior Art**

Reference is made to the following document:

D1: DE 101 44 877 A

D2: US-A-5 957 491

D3: PATENT ABSTRACTS OF JAPAN vol. 006, no. 096 (P-120), 4 June 1982 (1982-06-04) -& JP 57 029916 A (YOKOGAWA HOKUSHIN ELECTRIC CORP), 18 February 1982 (1982-02-18)

D4: EP-A-0 900 705

**V.2 Novelty, Inventive Step and Industrial Applicability**

1. The subject-matter of claim 1 meets the requirements of the PCT regarding novelty and inventive step (Article 33(2, 3) PCT).

D1 discloses the features of the preamble of independent claim 1, see seat occupancy sensor comprising a surface acoustic wave detection device (5) including a resonator (6) and an antenna (4), associated with a controller having an RF antenna (3) for remote communication, see paragraphs 13 to 22, Figures 1, 2 and 4.

The subject-matter of claim 1 differs from that of D1 by a dedicated pressure sensor electrically connected to the surface acoustic wave device in order to activate it. The object underlying said difference can be regarded as minimizing operating time of the surface acoustic wave detector. Detection of seat occupancy is achieved by the pressure sensor, and the surface acoustic wave device is activated only after such detection.

The available prior art does not disclose such a pressure sensor activating the surface acoustic wave device. D2 to D4 do not relate to such a pressure sensor, but to various design details of the surface acoustic wave device itself. The skilled man could therefore not get any indication towards the claimed solution.

**INTERNATIONAL PRELIMINARY  
REPORT ON PATENTABILITY  
(SEPARATE SHEET)**

International application No.  
**PCT/EP2004/052950**

2. Hence, the subject-matter of claim 1 is new and involves an inventive step. The dependent claims relate to further embodiments and meet the requirements of the PCT regarding novelty and inventive step due to their dependency. The subject-matter of claims 1 to 6 seems to fulfil the requirement of Article 33(4) PCT since it can be used at least in the vehicle industry.

**V.4 Remarks**

The claims do not include reference signs (Rule 6.2 b) PCT).

## Seat occupancy detector

### ***Introduction***

The present invention generally relates to a seat occupancy detector e.g. for use in an automotive vehicle.

In modern vehicles, seat occupancy sensors are widely used in order to detect whether a passenger seat is occupied or not. The information about the occu-

5 pancy of the passenger seat may then be used in order to control the deployment of one or more airbags associated to the passenger seat (the deployment is e.g. inhibited if the passenger seat is found to be non occupied) or in the triggering of a seat belt reminder.

10 The occupancy sensors usually comprise pressure sensing devices integrated in the respective passenger seat for detecting a pressure induced by the presence of a passenger into the seat. The pressure sensing devices, as e.g. disclosed in DE-A-42 37 072, comprise a plurality of individual force sensors, which are connected in a suitable manner to a control unit designed for measuring a pressure depending electrical property of said individual pressure sensors.

15 These occupancy sensors have proven to be very reliable and well adapted to the detection of seat occupancy. However one drawback of these occupancy sensors lies in the fact, that the pressure sensing device has to be physically connected to the control unit by means of connection wires in order to be functional. This need for physically connecting the sensing device to the control 20 unit causes problems in modern cars equipped with a flexible seating system with removable and/or displaceable back seats.

25 Document DE-A-101 44 877 discloses an occupancy sensor, which does not need to be physically connected to the control unit. The occupancy sensor comprises a surface acoustic wave device (SAW device), which is integrated into a seating surface. The SAW device is used for pressure measurement and for remotely transmitting pressure related data to the control unit.

***Object of the invention***

The object of the present invention is to provide a different seat occupancy sensor which is not depending on a physical connection between the pressure sensing device and the control unit.

***General description of the invention***

In order to overcome the abovementioned problems, the present invention

- 5 proposes a seat occupancy sensor, comprising at least one pressure detection device associated with a surface of a seat and a control unit for communicating with the pressure detection device. According to the invention said pressure detection device comprises a surface acoustic wave device including at least one surface acoustic wave resonator and an antenna and said control unit
- 10 comprises an RF antenna for remotely communicating with said surface acoustic wave device. Furthermore said pressure detection device comprises a dedicated pressure sensor, said dedicated pressure sensor being electrically connected to said surface acoustic wave device so as to activate said surface acoustic wave device when said dedicated pressure sensor is triggered.
- 15 A surface acoustic wave resonator consists of a piezoelectric substrate with metallic structures (interdigital transducers) on its plain-polished surface. Due to piezoelectricity an electric signal at the interdigital transducers will stimulate a surface acoustic wave on the surface of the substrate. Vice versa a surface acoustic wave generates an electric charge distribution at the receiving interdigital transducers which is measurable as an electric signal. In case of a one port surface acoustic wave resonator only one interdigital transducer is connected electrically while the other interdigital transducers are reflective. If the interdigital transducer is connected to an antenna, the element is operable as a passive wirelessly interrogable system.
- 20
- 25 As the velocity of the surface acoustic wave travelling along the surface of the piezoelectric substrate is depending inter alia on the environmental conditions at the sensor surface, the response of the surface acoustic wave devices depends on the environmental conditions. Thus the surface acoustic wave

devices may be used to measure environmental conditions such as pressure, temperature, etc.

The surface acoustic wave resonator is connected to a miniaturized antenna so that the surface acoustic wave device acts as a resonator. If a radio frequency

5 (RF) signal is sent to the surface acoustic wave device, the surface acoustic wave resonator oscillates at a frequency, which is depending on the given environmental condition in the vicinity of the surface acoustic wave device. The response signal of the surface acoustic wave device, which is wirelessly transmitted back to the control unit, may be processed in to control unit in order

10 to extract the information about the measured condition.

The remote operability of the surface acoustic wave device enables the seat occupancy sensor to be remotely operated and interrogated without the need for cabling between the pressure detection device and the control unit. Thus the seat occupancy status may be detected for all seats in a car without affecting

15 the flexibility of a seating system with removable and/or displaceable back seats.

It will be noted, that a single control unit may be used for operating and interrogating several pressure detection devices arranged in different seats of the car.

20 In a possible embodiment, the RF antenna of the control unit may be arranged in a region of the car, where communication is possible with surface acoustic wave devices as well in the front seats as in the rear seats. It will be appreciated, that in this case each of the surface acoustic wave devices associated to the different seats preferably operates in a different oscillating frequency range in order to be selectively addressable. Alternatively or additionally a radio

25 frequency tag may be integrated in each of the surface acoustic wave devices in order to ensure the addressability of each device.

It will be noted that surface acoustic wave devices are totally passive sensor devices which do not require a dedicated power supply. Thus there is no need to provide a battery power for the surface acoustic wave device of the seat

30 occupancy sensor of the present invention to be operable. Furthermore, surface

acoustic wave devices are characterized by their small size, low cost and rugged construction.

According to the invention, the pressure detection device comprises besides the surface acoustic wave device, a dedicated pressure sensor, which is associated

5 to the surface acoustic wave device. In this embodiment, the dedicated pressure sensor, which may be of any suitable type for use in a vehicle seat, is solely responsible for the pressure detection, while the surface acoustic wave device is used for the remote transmission of the respective pressure signal. In a preferred embodiment, said dedicated pressure sensor comprises a pressure  
10 sensitive switching device, said pressure sensing switching device being electrically connected to said surface acoustic wave device so as to activate said surface acoustic wave device when said pressure sensitive switching device is triggered. In this embodiment of the invention, the detection of seat occupancy is achieved by the pressure sensitive switching device and the  
15 corresponding information is transmitted to the control unit using the surface acoustic wave device's capability to remotely communicate with the control unit.

In a possible embodiment of this variant, the pressure sensitive switching device may have an electrical property (e.g. resistance) which varies depending on the pressure acting on the pressure sensitive switching device. Such a  
20 pressure transducer device may then be connected to the surface acoustic wave resonator in such a way, that the resonance frequency of the device is modulated by electrical property value of the pressure sensitive device.

In a preferred embodiment of the invention, the pressure sensitive switching device is connected in series between the surface acoustic wave resonator and  
25 the antenna. It follows that the pressure sensitive switching device acts as a switch for establishing an electrical connection between the surface acoustic wave resonator and the antenna. The surface acoustic wave device accordingly is only activated if the connection between the surface acoustic wave resonator and the antenna is established. The pressure sensitive switching device thus  
30 should be designed so as to close the electrical contact between the surface acoustic wave resonator and the antenna if a passenger is occupying the seat.

The pressure sensitive switching device may e.g. comprise a foil-type switching device, which is integrated into the seat. These foil-type switching devices are well known in the art and are available as simple switches or as pressure transducers.

- 5 In the absence of a seat occupant, the pressure sensitive switching device is not triggered and the surface acoustic wave device is accordingly not active. Thus the control unit does not receive a signal from the surface acoustic wave device. On the contrary, if an occupant is present, the switching device is triggered and the electrical contact between the surface acoustic wave resonator and the antenna is established. The control unit thus will receive a response signal from the surface acoustic wave device. In this embodiment of the invention, the presence or the absence of a response signal of the surface acoustic wave device gives the occupant detection information to the control unit.
- 10
- 15 In order to increase the active area of the seat occupancy sensor, the pressure sensitive switching device preferably comprises a plurality of individual pressure sensors or switches arranged at different locations with respect to the seat surface. The different individual pressure sensors may for instance be distributed over the seating surfaces of the seat so as to ensure detection of a passenger even in case of an out of position occupancy. The skilled person will appreciate that there exist different possibilities to connect the different individual pressure sensors between the surface acoustic wave resonator and the antenna.
- 20
- 25 The surface acoustic wave device of the present variant of the invention may be solely used in order to transmit the occupancy information to the control unit. However in a preferred embodiment, the surface acoustic wave is preferably adapted for the measurement of the temperature inside the seat, thus allowing for temperature compensation of the occupancy information. In this embodiment, the surface acoustic wave device accordingly comprises at least one acoustic wave resonator adapted for temperature measurement. Said surface acoustic wave resonator is e.g. able to oscillate at a given frequency depending
- 30

on the temperature inside the sealed chamber.

It will be appreciated that the present invention proposes a very flexible, robust and low cost seat occupancy sensor, which is suitable for wirelessly detecting seat occupancy for all of the seats of a vehicle. Furthermore it will be noted that

5 the seat occupancy sensor of the present invention may be used for different applications such as airbag deactivation (if a passenger seat is not occupied), seat belt reminders or others.

#### ***Detailed description with respect to the figures***

The present invention will be more apparent from the following description of several not limiting embodiments with reference to the attached drawings,

10 wherein

Fig.1: a top view of a vehicle seat seating surface with an embodiment of a seat occupancy sensor;

Fig.2: a section view of the seat occupancy sensor along the line A-A of fig. 14;

Fig.3: a schematic view of the operation of the occupancy sensor of fig. 1.

15 Fig 1 shows a top view on a seating surface 10 of a vehicle seat 12. A pressure detection device 114 is associated with the seating surface 10. In the shown example, the pressure detection device 114 is integrated in the car seat between the trim 16 and the seat foam 18.

Further to the surface acoustic wave resonator 28, the surface acoustic wave 20 device may comprise a second surface acoustic wave resonator 36 dedicated to the temperature measurement. As for the first resonator 28, the main inter-digital transducer of resonator 36 is coupled to antenna 30 of the surface acoustic wave device 26. If a radio frequency signal at a frequency  $f_1$  is emitted by the remote control unit 34, the signal is received by the surface acoustic 25 wave resonator 36 via antenna 30. The surface acoustic wave resonator 36 oscillates with a frequency  $f_1 + \Delta f_1$ , where  $\Delta f_1$  is e.g. proportional to the local temperature. This resonance frequency is sent back to and received by the control unit for data processing.

The pressure detection device 114 comprises a pressure sensitive switching device 120, which is associated with the seating surface 10 of the seat 12. The pressure sensitive switching device 120 may e.g. be integrated into the seat between the seat trim 16 and the seat foam 18. Alternatively the pressure  
5 sensitive switching device 120 may be integrated into the seat foam 18.

The pressure sensitive switching device 120 may comprise a simple membrane switching device or a pressure transducer. Preferably the pressure sensitive switching device 120 comprises several pressure sensitive switches or sensors 122, which are suitably distributed over the seating surface in order to increase  
10 the active area of the pressure sensitive switching device 120.

The pressure sensitive switching device 120 is connected to a surface acoustic wave device 126 in such a way as to activate said surface acoustic wave device 126 when one or more of said switches or sensors 122 of said pressure sensitive switching device 120 is triggered by an occupant 32.

15 Further to a surface acoustic wave resonator 136, the surface acoustic wave device 126 comprises a miniaturized antenna 130, which is connected to an interdigital transducer (not shown) of the surface acoustic wave resonator 136. This antenna enables the surface acoustic wave device to remotely and wirelessly communicate with a control unit 34 (not shown in figures 1 and 2)  
20 including an RF antenna 38. The RF antenna 38 of the control unit 34 is preferably arranged inside the vehicle at a location, at which the RF antenna "sees" the antennas 30 of different surface acoustic wave devices arranged in different vehicle seats.

In the shown embodiment, the pressure sensitive switching device 120 is  
25 connected in series between the surface acoustic wave resonator 136 and the antenna 130 of the surface acoustic wave device 126. It follows that the pressure sensitive switching device 120 acts as a switch for establishing an electrical connection between the surface acoustic wave resonator 136 and the antenna 130. Accordingly the surface acoustic wave device 126 is only activated if the pressure sensitive switching device 120 is triggered by the presence  
30 of an occupant on the seat.

In the absence of a seat occupant, the pressure sensitive switching device 120 is not triggered and the surface acoustic wave device 126 is not active. Thus the control unit 34 does not receive a signal from the surface acoustic wave device. On the contrary, if an occupant 32 is present, the switching device 120 is triggered and the electrical contact between the surface acoustic wave resonator 136 and the antenna 130 is established. The control unit 34 thus will receive a response signal from the surface acoustic wave device 126. The presence or the absence of a response signal of the surface acoustic wave device thus gives the occupant detection information to the control unit.

5 Surface acoustic wave resonator 136 may be solely used for its wireless communication capabilities. In this case, if the pressure sensitive switching device 120 is triggered and if a radio frequency signal with a frequency  $f_1$  is emitted by the remote control unit 34, the signal is received by the surface acoustic wave resonator 136 via antenna 130. The resonator then oscillates with a given frequency  $f_1$ , which is sent back to the control unit 34 if one or 10 several switches 122 are activated.

15

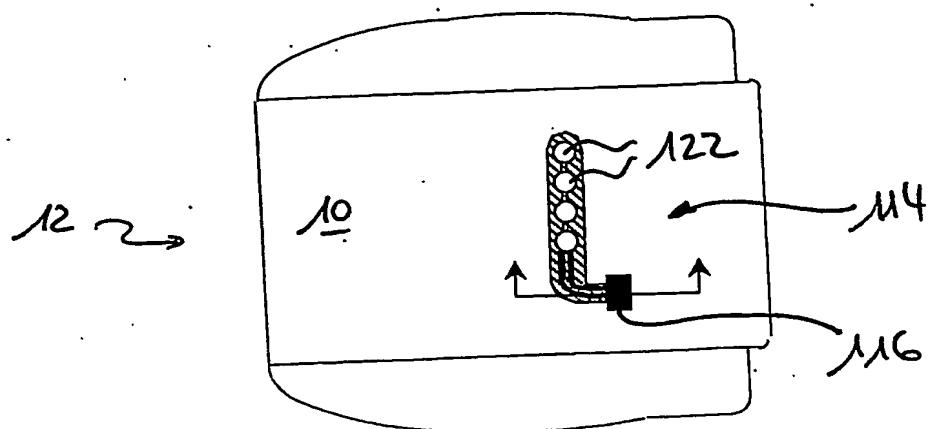
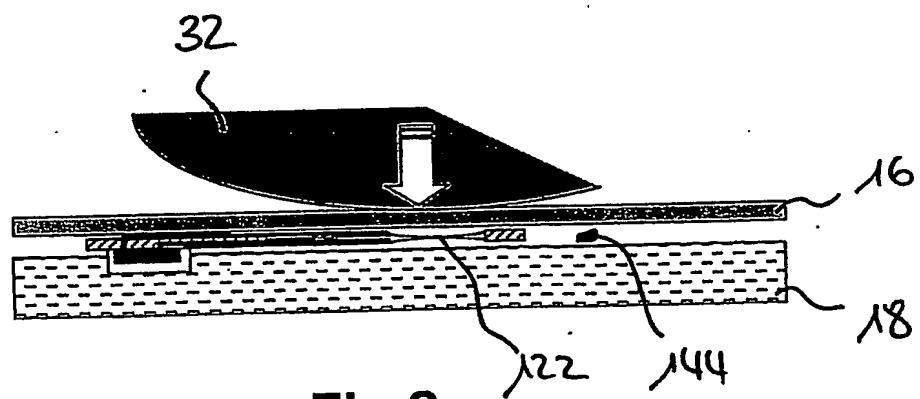
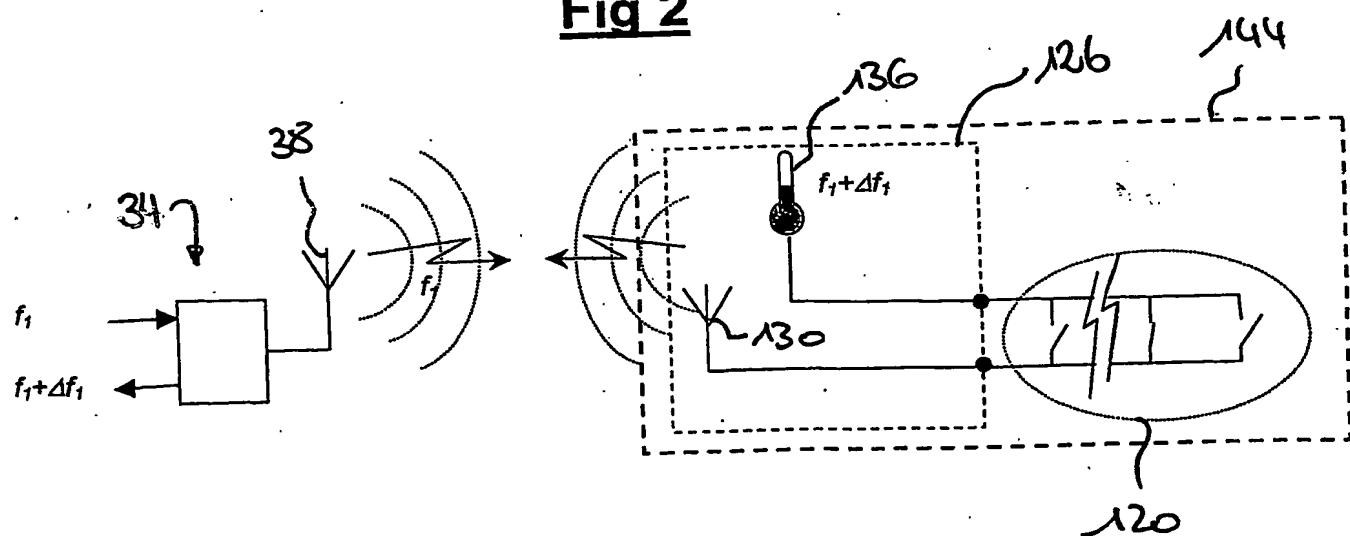
In the preferred embodiment shown in fig. 3, the surface acoustic wave resonator 136 is designed for temperature measurement. In response to an excitation field with frequency  $f_1$ , the resonator 136 then oscillates with a frequency  $f_1 + \Delta f_1$ , 20 where  $\Delta f_1$  is e.g. proportional to the local temperature. This frequency  $f_1 + \Delta f_1$  is sent back to and received by the control unit for data processing. After extraction of the temperature information, the sensed temperature may then be used for temperature calibration of the pressure sensitive switching device 120.

***Listing of reference numerals***

- 10 seating surface
- 12 vehicle seat
- 14 pressure detection device
- 16 seat trim
- 5 18 seat foam
- 20 sealed chamber
- 22 cavities
- 24 channels
- 26 surface acoustic wave device
- 10 28 surface acoustic wave resonator
- 30 miniaturized antenna
- 32 occupant
- 34 control unit
- 36 RF antenna
- 15 38 RF antenna
- 114 pressure detection device
- 120 pressure sensitive switching device
- 122 pressure sensitive switches or sensors
- 126 surface acoustic wave device
- 20 130 antenna
- 136 surface acoustic wave resonator

## Claims

1. Seat occupancy sensor, comprising at least one pressure detection device associated with a surface of a seat and a control unit for communicating with the pressure detection device, wherein said pressure detection device comprises a surface acoustic wave device including at least one surface acoustic wave resonator and an antenna and wherein said control unit comprises an RF antenna for remotely communicating with said surface acoustic wave device, characterised in that said pressure detection device further comprises a dedicated pressure sensor, said dedicated pressure sensor being electrically connected to said surface acoustic wave device so as to activate said surface acoustic wave device when said dedicated pressure sensor is triggered.
2. Seat occupancy sensor according to claim 1, wherein said dedicated pressure sensor comprises a pressure sensitive switching device, said pressure sensing switching device being electrically connected to said surface acoustic wave device so as to activate said surface acoustic wave device when said pressure sensitive switching device is triggered.
3. Seat occupancy sensor according to claim 2, wherein said pressure sensitive switching device is connected in series between the surface acoustic wave resonator and the antenna.
- 20 4. Seat occupancy sensor according to any one of claims 2 and 3, wherein said pressure sensitive switching device comprises a plurality of individual pressure sensors or switches arranged at different locations with respect to the seat surface.
- 25 5. Seat occupancy sensor according to any one of claims 1 to 4, wherein said surface acoustic wave device comprises at least one acoustic wave resonator adapted for temperature measurement.
6. Seat occupancy sensor according to claim 5, wherein said surface acoustic wave resonator is able to oscillate at a given frequency depending on the temperature inside the sealed chamber.

Fig 1Fig 2Fig 3